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# ZOOLOGICAL SCIENCES

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# Canadian Journal of Research

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## AN EXPERIMENT IN THE CONTROL OF THE CESTODE, *TRIAENOPHORUS CRASSUS* FOREL[1]

BY R. B. MILLER[2] AND H. B. WATKINS[3]

### Abstract

During an investigation of the life history of *Triaenophorus crassus* at Lesser Slave Lake it was found that the coracidia could be killed by increasing the acidity of their laboratory cultures to pH 5.0. In May, 1945, an experiment was carried out at Baptiste Lake, Alta., to determine whether the coracidia could be killed in the lake by acidifying the lake water with sulphuric acid. The experiment was a failure; the value of the work lies in the demonstration of the method used to assess the effects of the treatment.

The life history of the tapeworm, *Triaenophorus crassus* Forel, has been studied in Alberta by Miller (1, 2, 4). Briefly it is this: the adult tapeworm lives in the intestine of the pike (*Esox lucius* L.); here it reaches sexual maturity in early spring and releases its eggs, which, on finding their way into the water, very soon hatch. The minute larvae from these eggs are called coracidia. They are ciliated and have a one to two day free swimming life period during which they must be swallowed by *Cyclops bicuspidatus* Claus to survive. After a period of growth in *Cyclops* they must be swallowed by a coregonine fish to continue their development. In the fish they form cysts in the flesh; the worms in these cysts develop to adults if swallowed by a pike.

During the study of this life history it was found that the coracidia were sensitive to changes in pH and could be killed if the acidity of their cultures were increased to pH 5.0. Accordingly, we decided to try acidifying a lake where the parasite was present and determine whether any reduction in the infestation of the tullibee (principal coregonine host in Alberta) took place. The experiment was a failure but we feel the results should be put on record since they show a method of approaching the problem of tapeworm control that might prove successful if a satisfactory chemical is found. Also, some of our data confirm certain conclusions about life history details of the parasite reached previously by Miller (4) from less extensive observations.

The method used in the experiment is one of those suggested by Miller (3) in an Alberta Government publication. It consisted of finding a lake, prefer-

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ably a small one, where the tullibee were heavily infested with *T. crassus*; the extent of infestation of *each year class* of the tullibee was then determined. In the spring pike were collected and the adult tapeworms from their intestines examined to learn the time of the worm's spawning. Provincial Fisheries field men mapped the areas in the lake where the pike were congregating and where the tapeworm eggs would be released. An analysis of the lake water was made to determine the amount of acid needed to produce a pH of 5.0. At the height of the tapeworm spawning season acid was distributed in the required areas; these areas were treated twice during the spawning season. Later, in the summer and fall, further samples of tullibee were examined and the infestation of each year class again determined. By comparing these findings with the similar observations made before the acid treatment the effect of the treatment was assessed.

## The Lake

Baptiste Lake, near the town of Athabaska, was chosen for the experiment. It has an area of approximately eight square miles. The main pike spawning areas, however, are confined to a number of bays, which aggregate an eight mile strip about 20 ft. wide with an average depth of 3 ft. The alkalinity of the water was found to be 175 p.p.m. The amount of commercial sulphuric acid necessary to neutralize this alkalinity in this quantity of water was calculated to be 14.4 tons. The quantity needed to lower the pH from neutrality to 5.0 is insignificant; a slight increase over the 14.4 tons would have a very great effect on the pH. We decided to measure the pH of the lake as we worked and so determine the end point.

The outlet of the lake, Baptiste Creek, was screened to prevent the ingress of parasitized pike from the Athabaska River.

## Spawning Time of Tapeworm

Pike from Baptiste Lake were examined on Apr. 4, 5, 6, and 9; the state of ripeness of the tapeworms in their intestines was estimated as follows. The worms were placed in water; ripe worms immediately released a cloud of eggs from their uterine pores; unripe worms released no eggs or only a few after several hours. If the spawning time of the worms is close at hand, these liberated eggs show clearly defined embryos, which move within the egg shells. Hatching follows within 12 to 24 hr. If the spawning time of the worms is not close at hand, the outlines of the embryos are not distinct and hatching follows only after several days to a week; usually only a few of such eggs hatch.

A series of such observations was made and compared with similar ones made in previous years on worms from Lesser Slave Lake pike. From the comparison it was estimated that maximum spawning in Baptiste Lake would take place about May 15, one week later than in Lesser Slave Lake. Accordingly it was decided to introduce the acid during this period.

## Introduction of the Acid

Commercial sulphuric acid was distributed over the pike spawning areas (and, therefore, tapeworm spawning areas) during the period May 14 to 17, and again from May 22 to 29. The acid was carried in a steel barrel mounted in a cradle in the bottom of a boat; a second boat was fastened alongside to give stability; the combination was powered with an outboard motor. The acid was piped from the barrel and into the propeller disturbance of the motor so that it would be rapidly dispersed in the water. As soon as the acid mixed with the lake water the pH dropped below the range of our indicator (5.0); within a half hour or less, however, the upper waters had returned to their normal pH (pH 8.0). Very acid conditions existed in the bottom mud for several hours following the treatment; the acid evidently sank rapidly to the bottom and mixed very little with the water. The next day even the bottom mud had returned to its normal pH. A total of 20 tons of acid failed to increase the acidity for more than a few hours.

A small fish (stickleback) that swam into the stream of acid during the treatment showed no signs of distress.

## The Tapeworm Cysts in the Tullibee

During the period Mar. 28 to Apr. 10, 1945, six samples of tullibee, totalling 413 fish, were taken from Baptiste Lake. Field men cut each fish into small pieces and recorded the number of cysts of *T. crassus*. Lengths of the fish were recorded and a scale sample taken from each. Later the age of each fish was determined from these scale samples. With these data we established the degree of infestation of tullibee of each age in Baptiste Lake (Table I).

An additional three samples were taken during May, June, and July; the last sample was taken on July 6, 1945. A total of 224 tullibee was taken in these three samples. They revealed only a slight, and probably insignificant, increase in degree of infestation (Table I).

A final sample of 200 tullibee was taken Oct. 11 to 13, 1945, and studied in the same way as the previous samples. The findings for the three groups of samples are shown in Table I.

TABLE I

THE INFESTATION OF BAPTISTE LAKE TULLIBEE WITH CYSTS OF *Triaenophorus crassus* DURING THE PERIOD MARCH TO OCTOBER, 1945. FIGURES ARE NUMBER OF CYSTS PER 100 FISH; FIGURES IN PARENTHESES ARE NUMBERS OF FISH OF EACH YEAR CLASS

| Date | No. of fish examined | Year classes of fish | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1944 | 1943 | 1942 | 1941 | 1940 | 1939 | 1938 | 1937 |
| March and April | 413 | — | 0 (3) | 75 (4) | 305 (18) | 612 (146) | 875 (153) | 870 (78) | 100 (11) |
| May, June, July | 224 | — | 44 (162) | 103 (36) | 465 (17) | 715 (7) | — (1) | — (1) | — |
| October | 200 | 100 (2) | 217 (75) | 306 (33) | 836 (87) | 765 (3) | — | — | — |

The record for the year classes of 1941, 1942, and 1943 gives a clear picture of the facts. For each of these year classes the degree of infestation increased only insignificantly from March to July 6; from July 6 to October the infestation increased from two to nearly five times.

In studies of this tapeworm at Lesser Slave Lake, Miller (4) found the same increase in infestation of the tullibee during the summer of 1944. The increase occurred between June 15 and July 25; it was of the same order of magnitude as that noted in Baptiste Lake and shows, therefore, that the acid treatment of Baptiste Lake had no effect on the parasite. The Baptiste data offer a convincing confirmation of the conclusions based on the Lesser Slave data, namely, that the cysts of *T. crassus* become established in the flesh of tullibee in late July. The principal value of the present paper lies in these data, which make this point reasonably certain—a point that is crucial in assessing the value of any program for the control of this tapeworm.

## Discussions and Conclusions

The main conclusion from this work is that the treatment of part of a lake with acid is neither effective in changing the pH for an appreciable length of time nor in killing the coracidia of *T. crassus*. It has been suggested that the failure to acidify the water was due to rapid mixing with water from the untreated zone of the lake. Although this is a possibility it does not appear to the authors to be the main reason; the area treated was rather thickly grown with emergent aquatic plants, which tend to hold the water static; also during the period of the experiment there was little wind and no strong wave action. A more probable explanation is that the carbonates in the bottom mud (to where the heavy acid soon sank) neutralized the acid completely within a few hours. The fact that the bottom mud remained acid for some time proves that little diffusion into the surrounding water occurred.

We have illustrated the method that must be used in assessing the effect of any control program for *T. crassus*; and we have gathered data that give additional proof that the cysts of *T. crassus* reach the flesh of the second intermediate host (tullibee) late in July each summer.

## Acknowledgments

We are particularly indebted to the Imperial Oil Company at Calgary, who donated the sulphuric acid used in the experiment.

We are also indebted to the field staff of the Fisheries Branch, Department of Lands and Mines, Alberta, particularly Mr. L. Silver and Mr. F. Arnfinson who caught the fish and counted the parasites in them, and who distributed the acid in the lake.

We wish to thank Mr. J. A. Kelso, Alberta Provincial Analyst, who made the analysis of Baptiste Lake water.

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